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ABSTRACT

LogoWriter was introduced in this study as a tool to teach problem solving and thinking skills to students in Korean schools; teacher-mediated learning was also structured to help students monitor their thinking processes. In the teacher-mediated learning model, the following problem solving strategies were used: decomposing, planning, detecting errors, and debugging. Twenty-nine elementary and middle school students and 18 adult learners (most of whom were parents of the students) participated in the study. The adult learners had limited English learning experience and the students had no English background. Each LogoWriter lesson unit involved four main sections: (1) exploration; (2) co-construction; (3) journey through problem solving; and (4) working together. Teacher observation data indicated that the problem solving strategies became part of the students' thinking processes and that students tended to think more carefully and explain their answers more logically than other students when non-Logo problems were given. Adult learners reported that LogoWriter should be introduced in schools as part of the curriculum. Their computer anxiety was reduced dramatically and they found they could apply the learned problem solving skills to every day life. Even though the students did not know English, the language barrier did not interfere with their learning experience. In all, attitudes toward LogoWriter were extremely positive. (AEF)

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Turning Point for Korean Computer Educators: Introducing LogoWriter as a Thinking Tool

by Mi Ok Cho

Paper presented at the NECC '95, the Annual National Educational Computing Conference (16th, Baltimore, MD, June 17-19, 1995.

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Turning Point for Korean Computer Educators: Introducing LogoWriter as a Thinking Tool

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Abstract

Although most Korean schools still remain traditional "fill the vessel" learning environments, educators have agreed that there is a need for developing new learning tools and teaching methods to improve students' problem solving and critical thinking skills. This is a pioneer study to introduce LogoWriter to Korea. In this study, LogoWriter was used as a tool to teach problem solving and thinking skills to students. Teacher-mediated learning was also structured to help students monitor their thinking processes.

Theoretical background

As new information and technology emerge in society, the need for teaching students critical thinking skills and independent problem solving skills is dramatically increasing. Since computer education has become part of the school curriculum, educators have suggested that computers be utilized to teach thinking skills and problem solving skills.

For decades, it has been claimed that the nature of Logo provides a learning environment in which students can develop higher order thinking skills and problem solving strategies (Lee, 1991; Swan & Black, 1989; Papert, 1993; Watt, 1982). Visual turtle graphics in Logo encourage students to monitor on-going thinking processes and to explain how they think. The Logo environment is a miniature reality that allows students to explore their ideas and test their thinking. Thus, Logo has been considered a powerful programming tool which provides students with the opportunity to develop self-monitoring skills and problem solving skills.

However, there is conflicting evidence for this claim. Many empirical studies of the effectiveness of Logo programming on problem solving skills indicated that Logo alone is not enough to guide students toward the development of problem solving strategies. It has been indicated that Logo programming combined with teacher-mediated learning helps students develop higher order thinking skills and problem solving skills (Bamberger, 1984; Grangenett, 1988; Lee, 1991; Seidman, 1987; Swan & Black 1989). A teacher-mediated learning approach to teach Logo programming has been discussed as a method to encourage the transfer of problem solving skills to other learning domains.

In teacher-mediated learning, the teacher increases the students' responsibilities as they gain knowledge to perform complex tasks. As learning progresses, students gradually become independent from the teacher centered problem solving activities. They gradually control their on-going cognitive activities. Thus, teacher- mediated learning can assist students in focusing on the complex problem, to search for helpful information systematically, to develop insight, and to monitor their on-going activities (Feuerstein, Jensen, Hoffman, & Rand, 1985; Lee, 1991; Samuels, 1986).

Although most schools in Korea remain traditional 'fill the vessel' learning environments, Korean educators need to take a first step to adopt new learning tools and innovative teaching methods in order to teach students to become independent thinkers and problem solvers. Since Korean society is becoming increasingly complex, teaching students higher order thinking skills and problem solving skills is of major concern for educators. Particularly, computer educators have claimed that technology should be utilized as a turning point for Korean computer education.

Although educational hardware and software are outdated in Korean schools, some students have a chance to access new technology through private computer education institutes. However, most private computer education institutes focus on teaching technical skills, such as Basic programming, MS-DOS, word-processing, and graphics. Most private instructors have a background in computer science. Only a few instructors have a background in education. Thus, computer instructors

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have not utilized technology to teach students problem solving skills and thinking skills.

This study has been conducted as a pioneer step of introducing LogoWriter in Korea. Computer educators in Korea are not familiar with the Logo programming language. The Basic programming language has been emphasized in the schools, as well as, in private computer education institutes. The study examined the use of LogoWriter as a potential tool for teaching problem solving skills. Since the study has been conducted as a pioneer step, the results reported are based on anecdotal comments, interviews, and observation.

For this study, a new learning environment was utilized. First, LogoWriter was introduced as a new learning tool. Second, a teacher-mediated learning environment was provided to guide students to become independent problem solvers. The teacher-mediated learning adopted in this study consisted of three pedagogical elements. First, LogoWriter was selected as a thinking tool to encourage students to monitor their thinking processes. Second, specific problem solving steps were provided in the Logo environment, such as decomposing, planning, detecting errors, and debugging. Third, teacher-mediated intervention guided students to apply specific problem solving strategies. The teacher-mediated learning environment employed a Socratic Dialogue method to encourage students to mindfully approach problems and monitor their problem solving process.

LogoWriter-based teacher-mediated learning model

With the supportive evidence of teacher-mediated learning and Logo programming, LogoWriter-based teacher-mediated learning was structured. In the teacher-mediated learning model, the following components of specific problem solving skills were utilized in learning LogoWriter.

Decomposing : This process refers to breaking a complex Logo problem into smaller, manageable subproblems. The decomposing process allows students to simplify the complex programming procedure. Students were able to think 'mind-size bits' through the decomposing process.

Planning : This process refers to efficient solution strategies needed in order to accomplish a problem goal. Students were encouraged not only to plan the solution of a LogoWriter problem, but also to examine other possibilities for the solution and to select the most efficient turtle trip.

Detecting errors : This process refers to comparing the actual outcomes with the original problem, to locating possible errors in the procedures, and to explaining why the error occurred. This procedure is an extremely important problem solving process since it alerts students to note their misconceptions and misunderstandings. Logo provides an excellent environment to improve detecting error skills since it provides students with immediate graphic depiction of errors and explicit error messages.

Debugging : The debugging process refers to correcting detected errors. In this step, students were allowed to correct Logo programming commands on the computer.

Students needed to follow these problem solving steps continuously until the given problem was solved. These problem solving strategies were selected because they fit most naturally to the Logo environment.

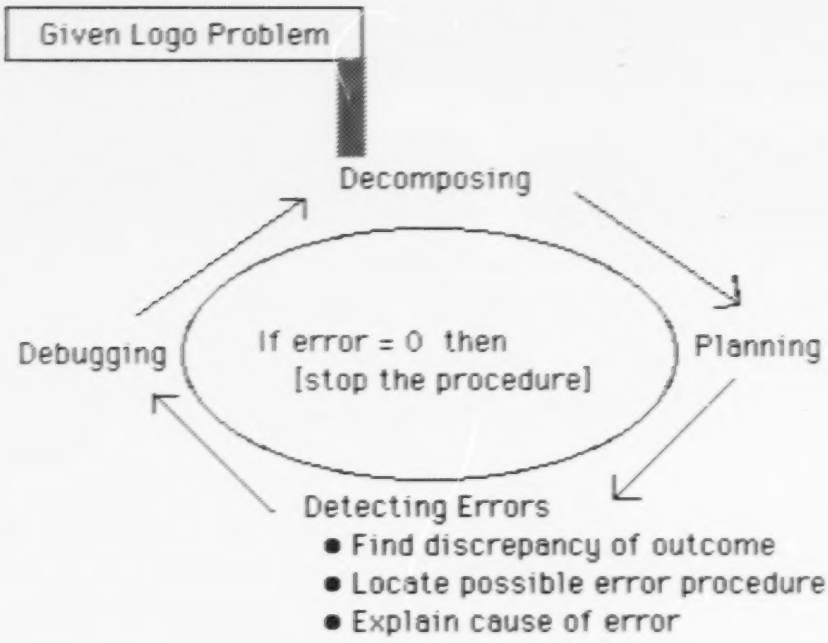

Figure 1. Recursive Problem Solving Process

Procedure

Sample

Forty-seven students and adult learners participated in this study. The study was sponsored by Saema-ul training center which was a government organization. Saema-ul headquarters opened a continuing education program in 1992. The LogoWriter program was selected, and was taught as part of computer education. The twenty-nine students ranged from second grade through middle school. This learning program was an extra curricular activity. About fifty percent of the students were fourth and fifth graders. About thirty percent had some computer experience. Only two students had learned the Basic programming language and were able to write short programs.

Eighteen were adult learners. Most of them were parents of students who participated in this study. Ninety-five percent of the adult learners had no experience with computers. Most of them had at least a high school diploma. Adult learners' ages ranged from thirty to fifty-five years old.

The Korean adult learners had limited English learning experience. The Korean elementary school students had no English background. Yet, the English version of LogoWriter was introduced.

Instructional procedure

The initial demographic questionnaire was given to the students and the adult learners before the instruction began. There were three sections of LogoWriter: Adult learner group, young student group, and old student group. The instruction was given three days a week. Students received two hours of LogoWriter instruction a day. LogoWriter instruction began in March, 1992 and continued through June, 1992. Two instructors were assigned to each session. Twenty three IBM compatible computers with VGA monitor were provided.

Each LogoWriter session consisted of the following procedures: (1) New Logo commands were introduced. (2) Students were given non-Logo activities or games so they could understand new commands better. (3) Then, a Logo problem was given and the instructors guided students to use explicit problem solving strategies. (4) Another Logo problem was given to all students. They worked individually to solve the problem and were encouraged to follow explicit problem solving steps on the activity sheet (Figure 2). (5) Finally, students were allowed to design their own project.

When students worked on their own project, they had to write each step of their problem solving activities. This way, when they had problems, the instructor was able to use Socratic dialogue to help the students find errors. The instructors could not give direct answers when students asked questions. Instead, they encouraged students to monitor their on-going thinking processes by using Socratic questioning.

Instructional materials

Each LogoWriter lesson unit involved Five main sections, exploration, co-construction, journey through problem solving, and working together.

1. Exploration

New LogoWriter commands were introduced to the students. Then, the instructor provided students with games and activities to help the students understand new commands easily. Since the English version of LogoWriter was used with Korean students, these activities were necessary. In this exploration unit, students were allowed to move around. Sometimes, students were divided into several groups and created their own games and activities using new LogoWriter commands. Some students even made a song using new commands.

2. Co-construction of problem solving skills

The instructors framed four explicit problem solving steps in the LogoWriter activity sheets (Figure 2). Then, the instructor carefully guided students to focus on each step thoughtfully. In this unit, learning Logo programming was emphasized less. The instructor used Socratic dialogue intensively to activate the students' thinking for an efficient decomposing, planning, detecting errors, and debugging. In the co-construction of problem solving skills, the instructor worked with students and they learned from each other. Then, students were given a new LogoWriter problem. They worked individually with the utilization of the learned problem solving strategies. The instructors continuously monitored students to see whether they used learned problem solving processes or not.

3. Journey through problem solving skills

In this step, each student was encouraged to design their own project. An empty activity sheet with explicit problem solving steps was given to the students. Students needed to design a specific project and to fill out the activity sheet as they developed the project. This activity sheet helped the instructor to communicate with students efficiently when they had problems. The problem solving strategy sheet also helped students monitor their thinking processes. Students were allowed to help each other and to discuss their problems with their peer group.

4. Working together

At the end of each month, a LogoWriter festival was held. Groups of three students designed a complex LogoWriter project and presented it to the whole group. They invited parents, friends, teachers, and relatives to the festival. Each group project was shown on the screen and visitors judged the final grand project. This 'Working together' unit enhanced the cooperative learning environment. Since the Korean school system is highly focused on competition, this unit provided a new aspect to the educational environment in Korea.

Results

Since this was the first time LogoWriter had been used in Korea, anecdotal data was gathered and reported as the results of the study. The teacher observation data indicated that students attempted to apply learned problem solving strategies to new learning domains. The problem solving strategies of decomposing-Planning-detecting errors-debugging became part of the students' thinking processes. However, the instructors struggled when introducing the problem solving model during the first few weeks since students were accustomed to a traditional learning environment where an answer was given immediately, memorizing content was highly encouraged, and high competition existed.

The instructors also indicated that students who participated in this study tended to think more carefully and explain their answers more logically than other students when non-Logo problems were given. Students themselves reported that whenever problems occurred, the learned problem solving strategies were automatically activated in their thinking processes. They also reported that they were able to use the problem solving strategies in their school work. This report encouraged LogoWriter instructors and parents.

Since all of the students experienced new software, various computer experience levels and grade levels did not cause great problems in learning LogoWriter. In fact two students who had previous Basic programming experience struggled the most to adopt the teacher-mediated learning. They wanted step-by-step instruction with direct answers. They learned technical skills, such as coding and operating systems very fast. However, they were impatient when the instructors guided them to use problem solving steps.

Adult learners who participated in this study reported that the LogoWriter should be introduced in school education as part of the curriculum. They also reported that learning LogoWriter brought a new and exciting learning experience to them. Their anxiety toward computers was reduced dramatically. Adult learners indicated that they applied the learned problem solving skills to every day life situations.

Attitudes toward LogoWriter were extremely positive. They enjoyed working on their own project. Even though students did not know English, the language barrier didn't seem to interfere with their learning experience. Even very young students were able to write structured Logo programs. Some of their projects were more creative than the adults' projects.

Recommendations for further study

It was difficult to conduct empirical research since LogoWriter was introduced to Korean students for the first time. However, anecdotal reports and observation data indicated a promising future for LogoWriter in Korean computer education. Without a doubt, LogoWriter contributed as a great tool in teaching explicit problem solving skills. The study clearly indi-

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cated that computers in the school should be used as a possible learning tool to teach thinking skills and problem solving skills.

As LogoWriter is introduced as a new promising learning tool, changing teachers' minds toward learning and teaching becomes the main issue in Korean schools. Along with this issue, instructional methodology in educational computing is another area to be researched.

Korean educators are facing the fundamental issue of teaching transferable skills to help students become independent learners and problem solvers in order to keep up with a rapidly changing society. Introducing LogoWriter with teacher-mediated learning to the public schools can be a major turning point for educators in Korea. This study demonstrated a successful instructional technique for developing problem solving strategies through LogoWriter.

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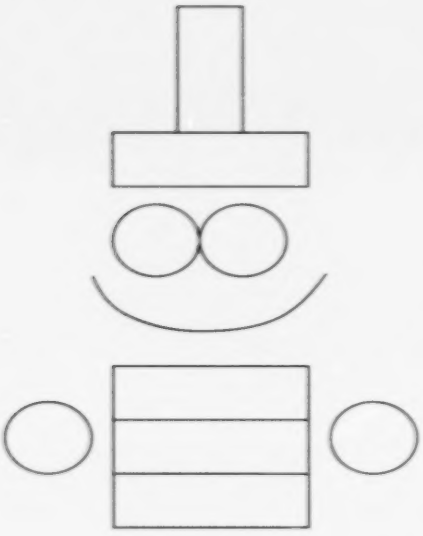
Activity Sheet 21



Decompose:

Plan:

Describe discrepancy between the given graphic and the actual outcome:

Find errors in the procedure:

Describe the causes of errors:

Debug:

Figure 2. Problem Solving Activity Sheet